

Forensic Odontology: Role in Mass Disasters

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Abstract

The term mass disaster means a chaotic event, initiated by a destructive force, which results in the multiple fatalities necessitating identification. The identification of large number of casualties in mass disaster is complex due to severe mutilation, charring and decomposition. The routine identification datas fall short in such cases. Teeth are the hardest and chemically most stable tissues in the body. Moreover, teeth and jaws are usually well protected from fire and mechanical trauma and are highly resistant to postmortem destruction and decomposition. Hence, dental identification is one of the most reliable methods of comparative identification in cases of mass disasters.

Key Words: Odontology, Casualty, Identification, Mass Disaster.

Introduction :

A mass disaster is defined as any event that occurs with or without warning and causes or threatens to cause death or injury, damage to property or to the environment and disruption of community, and whose effects are of such a scale that they cannot be dealt with by the emergency services and local authorities as part of their everyday activities, and therefore require the mobilisation and organisation of special and extra services. [1]

Mass disasters can be:

1. **Natural:** due to earthquakes, hurricanes, fire storms and floods.
2. **Accidental:** due to fires, transportation or industrial accidents.
3. **Manmade:** such as serial homicides, bombings etc. [2]

Forensic odontology – can be defined as a branch of dentistry, which deals with the proper handling and examination of dental evidence and with the proper evaluation, and presentation of dental findings in the interest of dentist. [2]

The forensic odontology is of prime importance in mass disasters where trauma is likely to make visual identification impossible. The great advantage of dental identification is that the teeth are the hardest and most resistant tissues in the body and can survive total decomposition and even severe fire, short of actual cremation. [3]

General principles of dental identification – applies to mass disaster identification. But mass disasters are associated with multiple fatalities scattered throughout broad areas, may be associated with loss of antemortem records, remains may be hidden, dismembered or mutilated and

proper facilities to carry out examination may not be available. So properly trained individuals work as a team to deal with such disasters. The dental team, which is involved in the process of identification, can be divided into two teams:

Home Team: This team is responsible for the collection of antemortem dental records of those believed to be missing. This group transmits the information to the away team.

Away Team: Is situated in the temporary mortuary near the accident site. This team performs examination of the victim, prepares the postmortem dental data and compares with the antemortem data provided by the home team. [2]

Procedures in dental identification

Dental identification depends mainly upon comparison between records of missing persons and the findings in the body in relation to:

1. Restorative work.
2. Unusual features.
3. Comparison of antemortem and postmortem X-rays.

The following particulars should be noted:

1. Complete charting of dentition using FDI system.
2. Type of dentition (either permanent or temporary).
3. The number, spacing, situation of teeth with special note of unerupted, decayed, undersized or oversized teeth.
4. The number and situation of absent teeth.
5. Extraction.
6. General condition of teeth - erosion, cleanliness, fillings, cavities, periodontosis.

7. Peculiarities of arrangement - prominence, ectopic teeth, overlapping, malposition, deformities, rotation and supernumery teeth.
8. Denture - full, partial, upper, lower, shape, restorative material used.
9. Mesiodistal width of the teeth.
10. Any peculiarity of jaw – prognathism.
11. Special features - incisal edges, fractures, ridges, caries etc.
12. Restoration and prosthesis - surfaces, morphology, configuration and material.
13. RCT - on X-ray.
14. Oral pathology - gingival hyperplasia etc.
15. Dental X-rays.
16. Photographic documentation of the dentition.
17. Odontograms-symbolic pictorial description of dentition. [4, 5]

The data thus obtained is useful to ascertain:

1. **Age:** Age assessment using teeth is the most reliable guide in process of identification. Eruption sequence, neonatal line formation, incremental lines and Gustafson's method are important parameters in age estimation. Further examination of mandible will help in assessing the age of an individual approximately. [6]
2. **Sex:** Sex can be determined from necrotic pulp tissue stained with quinacrine for fluorescent 'Y' chromosome, which is present in the teeth of males. In females, upper central and upper lateral incisors are equal in size and mandibular first molar has four cusps. [6]
3. **Race:** Race identification is useful in disasters where different races may be involved in an accident. Cephalic index helps to identify race. Characteristic shovel shaped incisors and cusp of carabelli are also used to determine race. [4]
4. **Individual identity:**
 - **Restorative Work and Dentures:** The technician who made the dentures may put the person's name and some form of personal identification on it or he may recognise his work even without some form of identification. [7]
 - **Unusual Features:** in dentitions as disease, deformity, supernumery teeth, prosthesis, oral pathology compared with antemortem records.
 - **Comparison of Antemortem and Postmortem X-rays:** Radiographs are better than charting for comparison as distinctive configuration of bony structures of jaw, roots of teeth and nearby sinuses often exist and are unique to each individual. In decomposed and charred bodies, jaws may be split down the midline in order to obtain better lateral films for comparisons to antemortem radiograph. [8, 9]
 - **Blood Grouping:** Blood groups can be determined from dental pulp and pulverized hard

tissues with less than 10 mg samples even after two years of death by using absorption elution technique. [2]

- **DNA Profiling:** is done using genomic DNA and mitochondrial DNA. DNA analysis can reveal the genetic profile of the individual pulp. DNA is analyzed using polymerase chain reaction. Postmortem DNA samples are compared with antemortem samples e.g. stored blood, hairbrush, clothing etc. [4, 10]
- **Computer Assisted Identification:** The computer assisted postmortem identification (CAPMI) software was introduced with the crash of the Arrow Air Charter aircraft in Gander, Newfoundland on December 12, 1985. The main drawback associated with this software was unavailability of original source codes for editing. In 1992, Win ID program was introduced with the desire to use the program in a windows format. Data base preparation, comparison, matching, using of tooth codes are the basic steps in Win ID program. [11]
- **Superimposition Technique:** Photographs may be compared with images of skulls or radiographs may be compared with photographs to reconstruct face. [12]

Results of postmortem identification

The American Board of Forensic Odontology recommends the following four conclusions in postmortem identification:

1. **Positive Identification:** The antemortem and postmortem data match in sufficient detail, with no unexplainable discrepancies, to establish that they are from the same individual.
2. **Possible Identification:** The antemortem and postmortem data have consistent features but, because of the quality of either the postmortem remains or the antemortem evidence, it is not possible to establish identity positively.
3. **Insufficient Evidence:** The available information is insufficient to form the basis for a conclusion.
4. **Exclusion:** The antemortem and postmortem data are clearly inconsistent. [13]

Conclusion:

With the increasing incidences of mass disasters in the present times due to natural calamities and terrorist activities, positive identification of victims is very important. In such a situation, dental comparison is an excellent method for making positive identification. However, an antemortem record must exist for comparison, with most desirable record being antemortem radiographs. The need of the hour is trained experts in Forensic odontology, proper maintenance of antemortem

dental records, and the use of computer assisted postmortem identification software to increase the efficiency and quality of dental identification. In the coming times, Forensic odontology will play a vital role in the positive identification of the individuals in case of a mass disaster.

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Anthropological Study of Human Auricle

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Abstract

Features of auricle had long been recognized as an important anthropological variable for studying racial variability and for identifying few genetic abnormalities at an early stage of life. So far there has not been any comprehensive study on auricle in India. An attempt has been made in this study to present somatometric and somatoscopic data relating to various parts of the auricle. Sexual and bilateral variations with respect to somatometric and somatoscopic parameters have been analyzed. Sample involves 280 Thakur males and females belonging to Sagar district of M.P. Ten direct somatometric measurements have been taken. The frequency of occurrence of various somatoscopic forms of auricle features were also presented in the study. Conclusions drawn from this study can be used as a supplementary source of evidence in identification system of ear biometrics, which is a promising new passive approach to Human Identification.

Key Words: Auricle, Somatometric, Somatoscopic, Biometrics, Thakurs.

Introduction:

Auricle has some of the most characteristic feature elements of the human body which are used in different anthropological studies. Various scientists systematically researched the shape and pattern of auricle and the complexity of different features. [1,2,3,4]. The use of morphology of auricle with other somatometric parameters as a means of establishing identity of persons was being explored and used by eminent French Criminologist Bertillon and other prominent forensic scientists of that time [5]. In India sporadic studies only relating to earlobe attachment, occurrences of Hypertrichosis and Darwin's tubercle have been reported [6,7,8]. To date no comprehensive study on auricle has been reported from India. A humble attempt has been made in the present study to present somatometric data and to determine frequency of occurrence of various somatoscopic forms of auricle and to analyse sexual and bilateral variations with respect to various somatometric parameters.

Material and Method:

A cross sectional study was undertaken in the Sagar district of M.P. among Thakur caste group. The sample size comprises of 280 individuals including 130 males and 150 females. Ten direct measurements (i) ear length, (ii) ear breadth, (iii) conchal length (iv) conchal width (v) lobular length (vi) lobular width (vii) Inclination angle of medial longitudinal axis of auricle (viii) Height of auricle at supraaurale level (ix) Height of auricle at tragal level (x) Protrusion level were taken. All direct measurements except measurement numbers (iii), (iv), (v) and (vi) were taken following Farkas method

[9, 10, 11]. The authors devised few measurements for the present study including conchal length, conchal width, lobular length and lobular width. Somatoscopic classification on various features of external ear was recorded by simple observation. Dial caliper, Goniometer, Protractor and Setsquare with instrumental error zero were used for taking measurements.

Result And Discussion:

The mean for various ear measurements of Thakur males and females have been depicted in the Table-1. Considering bilateral variation, measurements ear length, ear breadth, conchal length, lobular length and lobular width among males and measurements ear breadth, inclination angle and height of auricle at supraaurale level among females exhibited statistically significant bilateral variation. While considering sexual variation, all the ten measurements show very high statistical significant difference between the sexes.

Table -2 shows the somatoscopic characteristics observed among Thakur males and females. Most of the subjects have

Oval shaped auricle. Very few triangular shaped auricles were observed. Pre-auricular region and external auditory meatus was found to be normal. Majority of subjects have normally rolled helix. Wide helix covering scapha was totally absent in females. In nearly 15% males attached earlobe was observed which increased to about 25% in females. About one fourth of total males exhibited helical, meatal or lobular type of hypertrichosis.

Conclusions:

From the above account it can be concluded that bilateral and sexual variation exists with respect to different ear parameters. The Somatometric and somatoscopic data collected can be useful in the field of Plastic Surgery. The result of the present study also can be used in the field of Forensic Science for excluding criminals. The data collected

on large population can be used to test the hypothesis that the ear is unique. This knowledge will be useful in designing a new identification tool, Ear Biometrics besides fingerprints, iris scan etc. Ear Biometrics is a promising new passive approach to Human Identification system used for screening people.

Table-1
Simple Statistical Analysis of Somatometric Measurements among Thakurs

S. No	Measurements (in millimeter)	Male (N=130)				Female(N=150)			
		Right		Left		Right		Left	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
1.	Ear Length	59.05#*	3.85	60.02	3.62	57.69	1.94	57.85	2.10
2.	Ear Breadth	34.09#*	1.73	34.69	1.83	30.13*	0.94	29.85	1.28
3.	Conchal Length	28.91#*	1.84	29.45	0.72	25.55	1.05	25.48	0.98
4.	Conchal Breadth	22.34#	2.36	22.47	0.87	20.19	2.65	19.91	2.06
5.	Lobular Length	18.47#*	1.34	17.99	0.49	17.12	2.31	17.38	1.63
6.	Lobular Width	21.63#*	1.54	21.91	0.54	20.53	3.25	20.21	2.59
7.	Inclination angle (MLA)	18.68#	3.29	18.34	3.11	20.17*	2.35	21.00	2.65
8.	Height of auricle at Superaurale level	6.94#	2.32	7.22	2.68	7.96*	2.45	8.48	1.70
9.	Height of auricle at Tragal level	20.17#	3.74	20.46	3.35	18.24	3.75	18.72	3.83
10.	Protrusion angle	25.37#	4.39	25.80	4.88	22.33	4.18	22.26	4.16

= Sexual difference is significant at p< 0.05
 * = Bilateral difference is significant at p< 0.05
 S.D. = Standard deviation

Table-2
Somatoscopic Observations on Auricle

S. No.	Characteristics	Observations	Percent	
			Male	Female
1.	Shape of auricle	Round	42.23	40.19
		Oval	55.67	58.97
		Triangular	2.10	0.84
2.	Preauricular region	Normal	100.00	100.0
3.	External auditory meatus	Normal	85.38	90.25
		Narrow	14.61	9.75
4.	Anterior surface of each ear	Flat Helix	17.69	14.78
		Normally rolled Helix	78.46	85.32
		Wide Helix covering Scapha	3.84	-
5.	Tragus	Normal	76.92	80.44
		Small	13.08	10.12
		Large	10.00	9.44
6.	Developmental defects of each auricle	None	86.15	93.54
7.	Earlobe attachment	Slight hypoplastic and shape deformity	13.85	6.46
		Free	76.92	63.72
		Attached	13.07	5.68
8.	Hypertrichosis	Hypoplastic attached earlobe	10.01	10.62
		Absent	75.38	-
		Helical	13.09	-
		Meatal	5.38	-
		Lobular	6.15	-

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Medicolegal Study of Rigor Mortis to Estimate Postmortem Interval

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Abstract

Rigor Mortis is an important indicator of post-mortem interval. Though it is a reliable tool of estimating postmortem interval, it is influenced by many endogenous and exogenous factors. Temperature and humidity are very important factors, their relation with rigor mortis is Observed In The Present Study.

Key Words: Rigor mortis, Post mortem interval.

Introduction:

Estimation of time since death is an achille's heel in forensic medicine due to great individual variability of the postmortem changes as a consequence of many influencing factors. Rigor mortis is one such criterion which is being widely used to determine postmortem interval. A uniform time of appearance and disappearance of rigor mortis cannot be made applicable throughout a vast country like India where different weather conditions exist throughout its various parts at a given time. The present study was done to study the modifying effect of temperature and humidity on the development and extent of rigor mortis.

Material And Methods:

500 medicolegal autopsies were selected where the exact time of death was known and the body had been kept at prevailing room temperature. To observe the effect of atmospheric and seasonal conditions, the period of study was divided into four groups corresponding to the four seasons. A good quality digital hygrometer was used to note the daily readings of temperature and humidity. Presence or absence of rigor mortis and its extent was noticed in both voluntary and involuntary muscles. In the joints, appearance and disappearance of rigor mortis was noted by seeing their movements for resistance offered.

Observations:

In the present study 78.4% cases studied were males and 21.6% subjects were females. 56.2% victims belonged to rural area as compared to 43.6% urbanites while residence of 0.2% males was unknown.

Alleged cause of death in 42.6% cases was road traffic accidents, 11.6% deaths were due to poisoning, 9.2% victims had died due to natural disease, 9% due to burns, railway accidents formed 6.8% of the share and miscellaneous other causes contributed 20.8%.

66.2% cases were observed in 21-50 years of age group in which rigor mortis lasted longer as compared to 0-20 years (12%) and above 50 years (17.8%) age.

Effect of temperature and humidity:

In the months of April to June, fully developed rigor mortis lasted from 11 hours 25 minutes to 28 hours 25 minutes while in the quarter of July to September, complete rigor mortis lasted from 17 hours 15 minutes to 34 hours 20 minutes. **The maximum temperature during these months** ranged from 46.5°C to 26.6°C while minimum temperature ranged between 27.6°C to 12°C. Relative humidity levels in these months varied between 95% to 31% as shown in figure I.

In the months of October to December, fully developed rigor mortis lasted from 16 hours 25 minutes to 61 hours 5 minutes while from January to March it lasted from 19 hours 5 minutes to 50 hours 15 minutes. The maximum temperature during these months ranged from 35.4°C to 13.6°C while minimum temperature ranged between 20°C to -2.6 and the relative humidity varied between 97% to 65% as shown in Figure I.

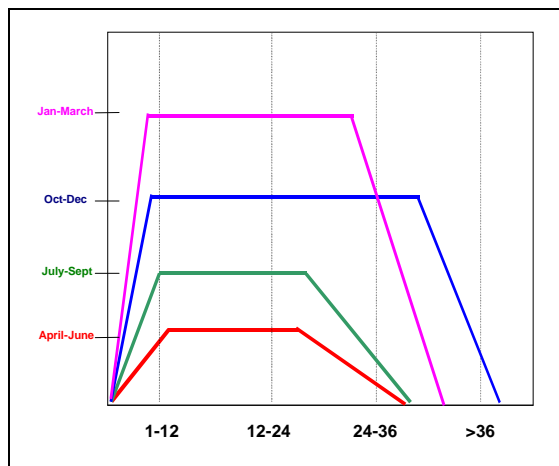
Time of appearance and disappearance: In the present study, it was observed that the average duration for onset of rigor mortis was 8 hours and 39 minutes. The maximum duration in which rigor mortis had begun to appear in the body was 1 hour and 35 minutes while the longest duration by which

rigor mortis had not completely appeared in the body was 24 hours.

The average duration for fully developed rigor mortis was 18 hours and 19 minutes, the shortest duration being 3 hours and 15 minutes and the longest 33 hours and 40 minutes.

The average duration for disappearing rigor mortis was 34 hours and 36 minutes. The shortest duration by which rigor mortis had disappeared had 15 hours and 30 minutes while one case was observed in which rigor mortis was presenting some parts of body at 70 hours and 35 minutes as shown in Figure I.

Fig. I: Showing Average Onset of Duration and Disappearance of Rigor Mortis



Sequence:

In 94.6% cases rigor mortis was found to appear first in the eyelids followed by lower jaw, neck, upper limbs, trunk, lower limbs and lastly fingers and toes. It disappeared in the same fashion. However, in 5.4% cases sequence was found to be erratic.

Site of recovery: In cases recovered from open environment, the average duration of onset of rigor mortis was early (6 hours 56 minutes) and average duration of disappearance was also early (24 hours 44 minutes) as compared to dead bodies recovered from closed environment.

Nourishment: In the present study it was observed that in well nourished individuals, the average duration of appearance of rigor mortis was early (6 hours 16 minutes) and it lasted for a short time (15 hours 45 minutes) as compared to moderately and

poorly nourished cases in which onset of rigor mortis was late and it stayed for a longer period.

Clothing: The average duration of onset of rigor mortis (6 hours 50 minutes) and disappearance of rigor mortis (27 hours 17 minutes) was earlier in naked dead bodies as compared to clothed victims.

Muscular activity prior to death: It was observed that in cases with history of muscular activity just prior to death the average duration of onset (8 hours 5 minutes) was late while the average duration for disappearance of rigor mortis (23 hours 33 minutes) was earlier as against those cases in which the muscles were at rest.

Conclusion:

In the hot weather from April to September, the average duration of onset was 8 hours 8 minute, complete rigor mortis lasted for an average duration of 18 hours 2 minute and average duration for disappearance of rigor mortis during these months was 30 hours.

In the winter months of October to March, the average duration of onset of rigor mortis was 7 hours 25 minutes fully developed rigor mortis lasted for 19 hours and 15 minutes and it disappeared at an average duration of 36 hours and 8 minutes.

The usually taught standard rule of twelve does not hold true in every case as the process of rigor mortis is influenced by many variables especially temperature and humidity which has been optimal observed in the present study. Much study has been done on laboratory animals by various workers all over the world but a more systematic and detailed study is required on human subjects beginning right from the time of death till the time of disposal. In a country like India with wide variations of weather, post mortem interval each and every state needs to have its own time table of rigor mortis so that it proves to be an effective tool for measuring post.

Average duration	Site of recovery		Nourishment			Clothing		Illness		Muscular activity	
	Open (38.80%)	Closed (61.20%)	Well (4.8%)	Moderate (90.8%)	Poor (4.4%)	Naked (4.8%)	Clothed (95.2%)	Present (8.6%)	Absent (91.4%)	Present (7.6%)	Absent (92.4%)
Onset	6.56	7.22	6.16	7.16	7.27	6.50	7.20	5.59	7.36	8.05	7.21
Complete	19.08	17.21	15.45	17.13	19.16	18.09	17.20	20.29	17.16	18.33	17.17
Disappearance	25.44	34.08		30.51	29.30	27.17	30.15	39.10	28.32	23.33	31.03

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Human Bite Marks : The Tool Marks of the Oral Cavity

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Abstract

Bite marks analysis is a vital area in Forensic Odontology, which constitutes the commonest form of dental evidence presented in criminal court. Bite marks are the tool marks left by the actions of teeth and other oral structures during the biting of objects and people. It plays an important role in identification of suspects especially in cases of battery, child abuse, rape and homicide. This article explores bite mark identification, histopathological and clinical parameters to analyse bite marks, bite mark preservation and its relevance in dental practice.

Key Words: Forensic Science, Forensic dentistry, Bite Marks.

Introduction:

Bite marks may be found on living or dead individuals where the person may be victim of the crime or perpetrator of the crime. McDonald has defined bite mark as a mark made by the teeth either alone or in combination with other mouth parts¹. Bite marks are the tool marks left by the actions of teeth and other oral structures during the biting of objects and people. They are useful in identification because the alignment of teeth is peculiar to the individual. Bite marks analysis is a vital area in Forensic Odontology, which constitutes the commonest form of dental evidence presented in criminal court.

History:

The first reported bite mark case was published in the 1870's while the pioneer to publish an analysis of bite mark is Sorup in 1924². He used transparent paper representations of a suspect's dentition and compared them with a life size bite mark photograph. Since then there are a number of cases reported involving bite mark evidence. Analysis of bite marks has improved with advanced and accurate techniques to evaluate, match and present bite mark cases.

There are seven types of bite marks, which can be classified by four types of impression³.

- Hemorrhage: undamaging mark on skin
- Contusion: ruptured blood vessel, bruise
- Laceration: punctured or torn skin

- Incision: near puncture of skin
- Avulsion: removal of skin
- Artifact: bitten-off piece of skin

The physical characteristics of both the bite mark wound and the suspect's teeth include

1. The distance between cuspid to cuspid
2. The shape of the arch
3. Width, thickness and spacing between the teeth
4. Missing teeth
5. The curves of biting edges
6. Wear patterns

Factors influencing appearance of bite marks:

Human skin is a poor medium for bite mark registration. The appearance of bite marks is influenced by both the mechanism and forces that produce them and by the mechanical properties of the skin / subcutaneous tissue or other bitten material.

1. Site variation: Bite marks vary from site to site because they are modified by mechanical properties of tissues. Eg: The tissues of the breast are innately softer than those of the back.
2. Directional variations at given sites due to preexisting tension lines (elastic fibers of the dermis) in the skin is known as Langer's line. Flexion, extension and rotation of

surface skin markings follow the pattern of these lines.

3. Other factors like curvature of the surface bitten, and dragging during the biting process, structure and vascularity of the tissue, medication, environmental factors etc.
4. Clothing through which the bite is inflicted, effects the injuries to some extent.

The age of an injury is the time elapsed from its infliction to the analysis of the damaged tissue. Reliable determination of the age of antemortem skin injuries requires histopathologic and histochemical analysis to relate the injury to the time of the alleged incident (Table 1) ⁴.

Methods to preserve bite marks evidence:

Impressions of bite site:

Impressions of bite site should be taken when indicated according to the American Board of Forensic Odontology (ABFO) bite mark analysis guidelines⁵. Dental acrylic or plaster can be used as a rigid support for the impression material. This will allow the impression to accurately record the curvature of the skin. Use vinyl polysiloxane, polyether or other impression material available in the dental office that is recommended for fixed prosthetic applications.

Bite print recording: ⁶

Similar to the method used to lift fingerprints from crime scenes, fingerprint lifting tape can be used to lift the non-perforating bite marks after brushing the bite mark with finger print lifting powder. Excellent clarity and detail is obtained with this method. There is no expertise required to lift the print and the versatility and the use of the fingerprint powder and brush technique is yet to be explored in bite mark investigations.

Saliva swabs of bite site:

Saliva swabbing of the bite site should be obtained whenever possible. Swabbings are done to collect DNA present in salivary trace evidence. The double swab technique⁷ involves moistening the site with a swab moistened with sterile saline, then removing the moisture with a second dry swab and both swabs are sent for analysis. Research has shown recovery of the biter's exfoliated epithelial cells from salivary trace evidence.

Photographic documentation of the bite site: ⁸

The most common method used to document and preserve bite mark evidence is through the use of photography. The bite site should be photographed using conventional photography and followed the

guidelines as described in the ABFO bite mark analysis guidelines. Close up photographs of the bite mark should be taken with ABFO scale No.2 and with out a photographic scale. Experienced photographers using both colour transparency and black and white film with a negative size of 35mm or larger should make photographs. Lighting, camera orientation, close-up capability and stability are extremely critical.

In addition to visible light photographic documentation, ultraviolet photography and digital photography can be used to record the bite mark injury.

The videotape documentation: ⁹

The videotape documentation demonstrated the three dimensionally of the bite in motion. The video equipment should be selected on the basis of four criteria like its portability, its quality of the image produced, its ease of use by untrained personnel and the intended use of the final image. This equipment can range from essential equipment such as lights and tripod to convenience equipment as simple as extension cords; play back units and editing facilities.

Radiographic documentation:

Bite marks can also be interpreted through soft tissue radiography. It has the advantage of penetrating the tissue there by revealing damage that might not be observed in photographic approach. Xeroradiography and contrast enhanced radiography¹⁰ can add valuable information and should be considered as an adjunct to standard photographic procedures.

Electron microscopic documentation:

Electron microscopy requires access to sophisticated and expensive equipment but can be invaluable investigative tool for the odontologist. Scanning electron microscopy¹¹ (SEM) is used for detailed examination of the surface configuration of bite marks. Energy dispersive X-ray analysis can be used along with SEM to enhance the surface topographic feature of bite mark site.

These documentation methods have to be compared with that of suspect's teeth. These methods include:

The most common method to determine if the suspect's teeth caused the bite mark include techniques to compare the pattern of the teeth with similar traits and characteristics present in life-sized photographs of the injury using transparent overlays. Overlays can be produced using various techniques. The most accurate technique has been found to be a method using a computer¹².

Other comparison methods include the direct comparison of the suspect's study cast with

photographs of the bite mark, comparison of test bites produced from the suspect's teeth with the actual bite mark, and the use of radiographic imaging and scanning microscopy.

Analysis of bite marks has been standardized by the ABFO and the degree of confidence that an injury is a bite mark is of 3 types¹³.

Possible bite mark: An injury showing a pattern that may or may not be caused by teeth could be caused by other factors but biting cannot be ruled out.

Probable bite mark: The pattern strongly suggests or supports origin from teeth but could conceivably be caused by something else.

Definite bite mark: There is no reasonable doubt that teeth created the pattern, other possibilities were considered and excluded.

Conclusion:

The science of bite mark analysis is relatively new and potentially valuable. This analysis has been instrumental in criminal investigations of homicide, sexual assault and abuse cases. Human dentition is influenced by genetic factors and environmental factors that determine the position of teeth in the arch. The dentist in practice observes the individuality of human dentition commonly but there is no database to express quantitatively this uniqueness of human dentition. More research is required to investigate bite mark accuracy and reliability in Forensic dentistry.

Table 1 : Histopathological and clinical changes to monitor the time elapsed in skin injuries associated with bite marks⁴

Time	Predominant cellular infiltrate and deposits	Healing	Clinical Colour
Hours 4-8	Predominant cellular infiltrate and deposits		Red-blue-purple
12	Polymorphonuclear leukocytes Macrophages		
16-24	Polymorphonuclear leukocytes		Blue-black
24-36		Peripheral fibroblasts	
Days 1-3	Central necrosis		Green-blue
>3	Hemosiderin		
4		Collagen fibers	
4-5		Capillary growth	Brown-yellow-green
6		Lymphocytes	
10-14		Granulation tissue	Tan-yellow

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A Roentgenographic Study For Age Determination In Boys of North-Eastern Region of India

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Abstract

A retrospective roentgenographic study of epiphyseal union of the elbow, knee, wrist joints and pelvis was carried out on 96 boys between the age group of 16 to 22 years for age determination. The findings are presented in this paper. Regression Formulae with the standard errors were derived for the respective joints. The Y-values predicted by the Regression equation may not be valid if they are outside the range of the Y-values used to determine the equation.

Key Words: epiphyseal union, age determination, regression formulae.

Introduction:

Age determination is an important step towards identification of individual as well as of unknown remains. Estimation of skeletal age from radiographs is a matter of everyday occurrence in every part of the world. Other reasons may be either as an adjunct to diagnosis or the monitoring of treatment of disorders of growth and sexual maturation. Determination of bone age is also of great medico-legal importance and serves as a very reliable evidence for age determination a person during admission to schools or colleges, employment, marriages, fixation of criminal responsibility and judicial punishment, etc. Further, age of majority is also essential in the context of civil and criminal responsibility.

Age can be established with considerable accuracy by roentgenography of skeleton from the time of its appearance about the 20th week of gestation until early adulthood. The epiphyses of bones unite during age periods which are remarkably constant for a particular epiphysis. This is possible due to complex but dependable system by which the osseous framework of the body develops, grows and matures. Banerjee KK and Aggarwal BBL¹ also stated that the study of epiphyseal union of bones is considered a reasonable scientific and accepted method for age determination by the law court all over the world.

The present study was carried out retrospectively to study roentgenographically the epiphyseal union of the elbow, knee, wrist joints and pelvis from the different boys of indigenous population belonging to the different North-eastern states.

Materials and Methods:

The study was carried out on 96 boys between the age group of 16 to 22 years. Only normal healthy individuals whose exact dates of birth were known were included in the study. Cases were collected

from schools, colleges and institutions by obtaining permission from the head of the institution. X-ray of the elbow, wrist, knee joints and pelvis were taken at the Department of Radiodiagnosis, Regional Institute of Medical Sciences, Imphal. The cases were taken from the groups of boys of the indigenous population belonging to the states of Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. Only the cases belonging to the tribal community were taken from the state of Tripura. The epiphyses examined were as follows: 1) At the elbow joint: Medial epicondyle, conjoint epiphysis, and upper ends of radius and ulna, 2) At the knee joint: The lower end of femur and the upper ends of tibia and fibula, 3) At the wrist joint: The lower ends of radius and ulna, 4) At the pelvis: The iliac crest and the ischial tuberosity.

A complete history of the past and present illnesses was taken and general physical examination was done meticulously to assess any disease or deformity which may affect the epiphyseal union. Dietary and economical parameters were also noted. The qualified candidates were subjected to x-ray of the bones around the joints mentioned above in anterior-posterior (AP) view.

The different phases of fusion were graded arbitrarily into five stages as:

- **Non-union:** When the epiphyseal cartilage did not begin to decrease in thickness (0 degree union).
- **Commence of union:** When the thickness of the epiphyseal cartilages was found to be reduced appreciably (1st degree union).

- **Incomplete union:** When the epiphyses have begun to fuse with the shaft and complete union was well underway (2nd degree union).
- **Complete union:** When the epiphyseal cartilage was bony in architecture and its density indistinguishable from the epiphyses and diaphyses in its neighborhood, but an epiphyseal line called epiphyseal scar could still be distinguished (3rd degree union).
- **Complete union** with absence of epiphyseal scar (4th degree union).

In the pelvis, the 0, 1st, 2nd, 3rd, and the 4th degrees of union has been assigned to the non-union, 25%, 50%, 75%, and complete union of the epiphyses respectively.

Results and Observations:

The degree of epiphyseal fusion in 16 years age groups is shown in Table: 1. At the elbow joint, the epiphyses had fused completely with their shafts at the age of 16 years. At the knee joint, 4th degree epiphyseal union is seen in 80% of the cases. At the wrist, 27% of the cases showed complete union whereas at the pelvis complete union is seen in 6.67% of the cases.

At 17 years age group they showed 4th degree union at elbow and knee joints. At the wrist joint, 69% of the cases showed complete union. At the pelvis, no complete union is seen in this age group (Table: 2).

Total number of cases in 18 years age group is 20. Complete union is seen at elbow and knee joints. At wrist joint, 95% of the cases showed complete union. At pelvis, 25% cases showed complete union in this age group (Table: 3).

At 19 years, complete epiphyseal union is seen around elbow, wrist and knee joints. At pelvis, 66.7% of the cases showed complete union (Table: 4).

Epiphyses around the elbow, wrist and knee joints showed complete epiphyseal union at 20, 21 and 22 years. At pelvis, the boys showed complete epiphyseal union in 83.3%, 90% and 100% of the cases at 20, 21 and 22 years respectively (Table: 5-7).

Table-6 shows regression equations for 16 to 22 years age group at different joints to predict ages with given degrees of union, where Y is the dependent variable (age) and X is an independent variable (degree of union). The standard errors of various joints are given in the Table-9 which corresponds to the different regression equations.

Regarding the individual bones of the joints concerned, the ages showing complete epiphyseal union in the 100% of the cases at the earliest has been summarized below:

Discussion:

Elbow joint: In the present series, epiphyses at the elbow joint showed complete fusion in all the

cases by the age of 16 years. Lall R and Nat BS² found that the conjoint epiphysis fused with the shaft at 15-16 years whereas the medial

Conjoint epiphysis	16 years;	Medial epicondyle of humerus	16 years
Upper end of radius	16 years;	Upper end of ulna	16 years
Lower end of radius	19 years;	Lower end of ulna	18 years
Lower end of femur	17 years;	Upper end of tibia	17 years
Upper end of fibula	17 years;	Ischial tuberosity	21 years
Iliac crest	22 years;		

epicondyle fused at about 17 years, which is almost similar with the present series. Borovansky L and Hnevkovsky O³ in their study on Prague subjects found that the complete union of the epiphyses at the elbow joint took place by the age of 18 years. Their finding is much later than the finding in this series. In distal epiphyses of radius and ulna the majority of the cases showed complete epiphyseal union by the age of 17 years. Cent percent cases showed complete union at 19 years in the present series. Standing S⁴ documented that the distal end of radius fused with the shaft at about 19 years male. He further stated that the distal end of ulna fused with the shaft at the age of 18 years in male. Similar findings are observed in the present series. Kothari DR (1974) found that the distal ends of both radius and ulna fused completely with their shafts at 17-18 years in female and 18-19 years in male, which is in agreement with the findings in our study.

Wrist joint: Banerjee KK and Aggarwal BB (1998)⁵ showed that the epiphyseal union around the wrist joint is completed in all cases in the age group of 19-20 years in male. In the present series, the epiphyseal union occurred about one year earlier than the finding in their series. Borovansky L and Hnevkovsky O (1929)³ stated that the distal ends of radius and ulna fused with their shafts at about 19 years. The age of epiphyseal union of various bones, in this series, are almost similar to their observations. The correlation coefficient at this joint for male in our present study is 0.5001, which showed moderately positive correlations. The Regression equation is $Y=13.33+1.41X$ with a standard error of +/-1.61.

Knee joint: All the cases showed complete union (4th degree) of all the epiphyses at the age of 17 years. Out of 96 cases, 80% showed 4th degree union by 16th year. Like in other joints the commencement of the epiphyseal union could not be studied. Standing S (2005)⁴ stated that in male the upper end of tibia fused with the shaft at about 18 years, the upper end of fibula fused at 19 years and the lower end of femur fused with the shaft at 18 years. Similar findings are seen in the present series. According to Saksena JS and Vyas SK

(1969)⁶, in the boys the epiphyseal union around the knee joint is completed by the age of 20-21 years which are much later than the findings in this series. In the present study the correlation coefficient at this joint for male is 0.25 and regression equation is $Y=15.14+0.88X$ with a standard error of +/-1.8.

Pelvis: The epiphyseal union for the iliac crest and ischial tuberosity were studied. In the present series, boys showed complete epiphyseal union at the age of 22 years. At 16 years 6.67% of the cases showed 4th degree union. Complete fusion at 17 years is 0%, at 18 years, 25%, at 19 years, 66.7%, at 20 years, 83.3%, at 21 years 90% and at 22 years it is 100%. Hollinshead WH (1969)⁷ documented that the iliac crest and the ischial tuberosity fused to the main mass by the age of 20-21 years. This is in support of the present series. Sankhyan S et al (1993)⁸ also found that the iliac crest fused with the mass, ilium at the age of 21.5 years, which is similar to our finding. Galstaun G (1937)⁹ documented that the iliac crest showed complete fusion at 19-20 years in boys. According to him complete fusion of the ischial tuberosity occurred at 20 years. These findings are slightly earlier than our findings in this series. The correlation coefficients at this joint for boys is 0.79 and the regression equation is $Y=16.33+0.89X$ with a standard error of 1.14.

According to various workers, the time of union of epiphyses varies with geographical distribution, and differences in dietary and hormonal factors. Regarding the North-Eastern region of India, the genetic and epigenetic factors like dietary and geographical distributions may play a role in the age of epiphyseal union.

Different workers used different criteria for epiphyseal union and for generalization. Dasgupta SM et al, 1974¹⁰ used the group showing 100% union at the earliest as the criteria for generalization. Lall R and Nat BS (1939)¹¹ used 75-90% union as the criteria for generalization. In

the present series, the age group showing 100% union at earliest was taken as the criteria for generalization. Therefore, the difference in selecting the criteria for generalization, and difference in the methods used for staging the epiphyseal union, may play a role in the variations of results and observations of various workers. Asymmetrical union as reported by Das R et al, 1965¹² was not seen in this series.

Conclusion:

There is no appreciable difference in the age of complete union of epiphyses on both right and left side of the body. In boys the following are the observations made in the epiphyseal union. The epiphyses around the elbow joint are completely fused by the age of 16 years. At the wrist joint the complete union of epiphyses is seen at the age of 19 years. At the knee joint the epiphyses shows complete union at the age of 17 and regarding the pelvis, the epiphyseal union is completed by the age of 22 years in boys. The commencement of the epiphyseal union could not be studied since the cases below 16 years are not included in the study. Regarding the correlation between the ages and the degrees of union, among the joint studied, there is zero correlation in case of elbow joint. Therefore suitable Regression equation could not be formulated for these joint. Other joints show moderately positive correlation. The Y-values predicted by the Regression equation may not be valid if they are outside the range of the Y-values we used to determine the equation. The age of a person can be determined by using the following Regression equations given below for the age group of 16-22 years:

Wrist: $Y=13.33+1.41X$ with a standard error of +/-1.61.

Knee: $Y=15.14+0.88X$ with a standard error of +/-1.8.

Pelvis: $Y=16.33+0.89X$ with a standard error of +/-1.14.

Table-1
Degree of epiphyseal fusion in 16 years age group

Degree of EPIPHYSEAL Union	Elbow n=15		Knee n=15		Wrist n=15		Pelvis n=15	
	No.	%	No.	%	No.	%	No.	%
0	0	0	0	0	0	0	11	73.3
1	0	0	1	6.667	2	13	2	13.3
2	0	0	1	6.667	3	20	1	6.67
3	0	0	1	6.667	6	40	0	0
4	15	100	12	80	4	27	1	6.67
Total	15	100	15	100	15	100	15	100

Table-2
Degree of epiphyseal fusion in 17 years age group

Degree of EPIPHYSEAL Union	Elbow n=16		Knee n=16		Wrist n=16		Pelvis n=16	
	No.	%	No.	%	No.	%	No.	%
0	0	0	0	0	0	0	10	62.5
1	0	0	0	0	0	0	4	25
2	0	0	0	0	2	13	1	6.25
3	0	0	0	0	4	25	1	6.25
4	16	100	16	100	11	69	0	0
Total	16	100	16	100	16	100	16	100

Table-3
Degree of epiphyseal fusion in 18 years age group

Degree of EPIPHYSEAL Union	Elbow n=20		Knee n=20		Wrist n=20		Pelvis n=20	
	No.	%	No.	%	No.	%	No.	%
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	2	10
2	0	0	0	0	0	0	6	30
3	0	0	0	0	1	5	7	35
4	20	100	20	100	19	95	5	25
Total	20	100	20	100	20	100	20	100

Table-4
Degree of epiphyseal fusion in 19 years age group

Degree of EPIPHYSEAL Union	Elbow n=15		Knee n=15		Wrist n=15		Pelvis n=15	
	No.	%	No.	%	No.	%	No.	%
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	2	13.3
3	0	0	0	0	0	0	3	20
4	15	100	15	100	15	100	10	66.7
Total	15	100	15	100	15	100	15	100

Table-5
Degree of epiphyseal fusion in 20 years age group

Degree of EPIPHYSEAL Union	Elbow n=12		Knee n=12		Wrist n=12		Pelvis n=12	
	No.	%	No.	%	No.	%	No.	%
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	2	16.7
4	12	100	12	100	12	100	10	83.3
Total	12	100	12	100	12	100	12	100

Table-6
Degree of epiphyseal fusion in 20 years age group

Degree of EPIPHYSEAL Union	Elbow n=10		Knee n=10		Wrist n=10		Pelvis n=10	
	No.	%	No.	%	No.	%	No.	%
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	1	10
4	10	100	10	100	10	100	9	90
Total	10	100	10	100	10	100	10	100

Table-7
Degree of epiphyseal fusion in 20 years age group

Degree of EPIPHYSEAL Union	Elbow		Knee		Wrist		Pelvis	
	No.	%	No.	%	No.	%	No.	%
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	8	100	8	100	8	100	8	100
Total	8	100	8	100	8	100	8	100

Table -8
Regression Equation at Different Joints

Joint studied	Regression Equation
Elbow	$Y=18.57+(0)X$
Wrist	$Y=13.33+1.41X$
Knee	$Y=15.14+0.88X$
Pelvis	$Y=16.33+0.89X$

Table-9
Standard errors at different joints

Joint studied	Standard Error
Elbow	± 3.46
Wrist	± 1.61
Knee	± 1.8
Pelvis	± 1.14

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Fixation of 16 Year of Age by Radiological Study of Shoulder Joint (A Jaipur Based Study)

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Abstract

Law in many legal matters requires estimation of age especially when age of accused or victim is in question for framing of charges by the law enforcement agencies. Sixteen years is very important particularly in girls because of age for giving consent for sexual intercourse. The present study has been undertaken to explore the pattern of diaphysis-epiphyseal union in the bones of shoulder joint in growing population of Jaipur region. Many factors are responsible for variation in timing of the epiphysis of bones. The present study has been conducted on 130 subjects (65 girls and 65 boys).

Key Word: Age Estimation, Shoulder Joint, Radiological.

Introduction:

Estimation of reasonably accurate age plays a pivotal role in civil/criminal cases like personal identification, fixing of criminal responsibility judicial punishment. There is variation in the timing of union of the epiphysis of bones & it has been attributed to factors like climate, heredity, race, nutrition, dietary habits, gender and socio-economic status of population for study. Survey Committee appointed by Central Government recommended for a Zone wise study. (1)

Keeping in view the above statement and great medicolegal importance of 16 years of age along with difficulty in estimating the 16 years age particularly in girls and also that no study what so ever done in Rajasthan where mixed population resides. The present study has been undertaken to explore the pattern of diaphysis-epiphyseal union in the bones of shoulder joint in growing population of Jaipur region.

Aims and Objectives:

1. To assess the general maturity for a known chronological age in either gender.
2. Study of average age of appearance of ossification centers around shoulder joint.
3. Comparative study of appearance and fusion of ossification centers on shoulder joint in boys and girls.
4. Comparative study of appearance and fusion of ossification centers in boys and girls with available data of previous work carried out in India.
5. Comparative study of appearance and fusion in boy and girls of present study with previously available foreign data.

6. Comparative study of appearance of third molar, secondary sexual characters and various demographical determinants with radiological process of fusion around shoulder joint.

Material and Methods:

This study is carried out in the Department of Forensic Medicine and Toxicology of S.M.S. Medical College and Hospital, Jaipur. The subjects are selected randomly from various schools, from neighborhood of various faculty members and staff as well as cases attending the OPD of the Forensic Medicine Department of S.M.S. Hospital, Jaipur.

Selection criteria for inclusion of person in present study:

For selection of subjects, following fact were recorded and considered:

1. They should be living in Jaipur region for more than 5 years.
2. They should be free from any physical disability or endocrinal anomaly.
3. Person should have accurate record of their date of birth.
4. Informed expressed verbal consent of the subjects was taken before proceeding to their physical, dental and radiological examination.

The person selected for study were grouped as per their stated age, viz.: 13-14 years, 14-15 years, 15-16 years, 16-17 years, 17-18 years, 18-19 years, 19-20 years and 20-21 years.

Age, as stated by them is further confirmed by birth certificate or entry in their school record.

The person belonging to the age group selected for the study of either gender are included in the study irrespective of their socioeconomic, religious and educational status, each person so chosen on the

basis of criteria as mentioned above are evaluated clinically in details as per Performa annexed.

After obtaining informed expressed verbal consent for their radiological and clinical examination each person is X-rayed for shoulder joint and subsequently the appearance, process of fusion and post fusion scarring.

Radiological Criteria for Epiphyseal Fusion:

The union is taken as complete when the:

- a. Diaphyseo-epiphyseal space is completely obliterated and become bony in architecture and density.
- b. There is continuity of the periosteum between ephphysis and diaphysis with no notching at the periphery of epiphyseal line.
- c. Presence or absence of epiphyseal scar (a white, transverse line) has disregarded in this connection and considered as recent complete union.

For generalization, fusion in more than 75% case is relied upon as complete fusion.

In the present study, the following points were noted with reference to each epiphysis in either the gender separately:

- Age of the youngest subjects showing fusion of epiphysis with diaphysis.
- Age of oldest subject not showing fusion epiphysis with diaphysis.

- The range of fusion with its relation to each epiphysis covering the upper and lower ages.
- Age at which at least 75% or more of the cases have shown fusion.

Data Collection:

Radiological data of appearance and fusion of various ossification centers were reduced to tables of various age group along with other physical data noted previously. These data were once again, examined and tallied by experts in Forensic Medicine and Radio-diagnosis. Data thus obtained finally, were analyzed and compared with the published work of various Indian and foreign works.

Observation & Discussion:

The present study has been conducted on 130 subjects (65 girls and 65 boys). In school going subjects, date of birth was confirmed from the verbal statement, record of school, secondary school certificates etc. all the subjects and were bonafied residents of Rajasthan and are residing in Jaipur for more than 5 years and were free from physical and mental illness, disability and long lasting disease.

Physical including dental and radiological examination was conducted in the Department of Forensic Medicine and toxicology of S.M.S. Medical College Hospital, Jaipur. Informations and parameters thus deduced are recorded in the master Chart.

Table : 1
Progress of Epiphyseal Union in different Bony Components of Shoulder Joint in Boys

Name of Epiphysis	Different Age Groups Showing % Fusion							
	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21
Head of humerus	-	14.28	30.00	50.00	78.57	100	100	100
Acromion Process	-	14.28	40.00	71.42	78.57	100	100	100
Coracoid Process	-	14.28	40.00	64.78	78.57	100	100	100

Table : 2
Progress of Epiphyseal Union in different Bony Components of Shoulder Joint in Girls

Name of Epiphysis	Different Age Groups Showing % Fusion							
	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21
Head of humerus	12.5	41.66	83.33	90.00	100	100	100	100
Acromion Process	12.5	41.66	83.33	90.00	100	100	100	100
Coracoid Process	12.5	41.66	93.33	100	100	100	100	100

In case of boys findings of Head of humerus in present study are in accordance with the L.A. Wadded (2), Galastaun (3), T.A. Gonzales (4), J.

V. Basmajian (5), and not in accordance with Lall and Nat (6), Pillai (7), S.N. Sahana (8), K.S. Narayan Reddy (9), Chaurassia B.D. (10) F. E.

Camps (11), Peter L. Williams (12), S. Cochrane Shanks (13), Flecker (14), Davies and Parson (15), Bernard Knight (16), and Kragman (17).

In case of girls above cited findings of present study are in accordance with Gaiastau, Pillai and Basu & Basu (18).

In the study conducted by Laa and Nut, S.N. Sharma, Chaurasia B.D., corresponds with Pillai, Galastaun, KS Narayan Reddy, J.V. basmajan, Flecker, Bernard knight and Krogman and not in accordance with C.K. Parikh, (19), Chaurassia B.D., T.A. Gonzales, F.E. Camps, Peter L. Williams, S.C. Shanks.

In case of girls the findings of present study are consistent with Galastaun and F.E. Camps and not consistent with Pillai, C.K. Parikh, K.S.N. reddy, Chaurassia B.D., T.A. Gonzalis, Peter L. Williams, J.V. Basmanjians, S.C. Shanks, Bernard Knight and Krogman.

In case of boys findings of present study for coracoid process are consistent with Galastaun, Chaurassia B.D., T.A. Gonzales, Peter L. Williams and SC Shanks and in consistent with L.A. Waddae, C.K. Parikh, K.S. Narayan Reddy, F.E. Camps, J.V. Basmajian and Krogman.

In case of girls the findings of present study corresponds with L.A. Waddale, Galastaun, KS Narayan Reddy, Chaurassia B.D., F.E. Camps, J.V. Basmajian, S.C. Shanks and Krogman and not corresponds with T. A. Gonzales and Peter L. Williams.

In the study conducted by T.A. Gonzales fusion of coracoid process occurs at a later age that present study and in the study by Peter L. Williams fusion occurs at an earlier age that present study 15-16 years.

Development of Secondary Sexual Character:

It is observed that in boys of present series pubic, axillary and facial hair grow at the age of 14, 15, 16 year respectively in majority of the case in their age group respectively. The voice of the majority of cases in boys was found to be

man like or low pitched at the age of 16-17 years onwards and the Adams apple become prominent at the age of 16 years onwards.

These findings are consistent with reported findings of Modi (Textbook of Medical Jurisprudence and Toxicology, 1988).

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Age Determination of Manipuri Girls From the Radiological Study of Epiphyseal Union Around the Elbow, Knee, Wrist Joints and Pelvis

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Abstract

In this study, X-rays of the elbow, knee, wrist joints and pelvis were taken in 100 Manipuri (Meitei – the majority group) girls to determine the age of majority. Regression Formulae with the standard errors were derived for the respective joints.

Introduction:

Age determination is essential to establish the identity of a person at the time of admission in school, college or institute, sports meets, employment, marriage, fixation of criminal responsibility, judicial punishment, etc.

According to Banerjee KK et al², the study of epiphyseal union of bones is considered a reasonable scientific and accepted method for estimation of age by the court of law all over the world.

The present study has been undertaken to study the degree of epiphyseal union around the elbow, knee, wrist joints and pelvis and thereby determine the age of majority of the Manipuri girls.

As reported by many workers, the important age range at which fusion of the epiphyses around these joints take place is between 14-19 years. Therefore, for the present study, the subjects of the age group of 16-20 years have been selected to come closer to the age of majority i.e., 18 years.

Materials and Methods:

100 Manipuri Meitei girls, born and brought up in Imphal, ages ranging from 16-20 years were X-rayed at the elbow, knee, wrist joints and the pelvis. The epiphyses studied at these joints were:

1. Elbow joint: medial epicondyle, conjoint epiphysis, upper ends of radius and ulna
2. Knee joint: lower end of femur, upper ends of tibia and fibula.
3. Wrist joint: lower ends of radius and ulna
4. Pelvis: iliac crest.

Complete personal, family and dietary history was taken and general physical examination of the subjects was done before taking the X-rays.

Staging of the degree of fusion:

Degree 0: A dark radioluscent line seen throughout the length of the epiphyseal and metaphyseal joining surfaces.

Degree 1: Radio-opaque area is seen in the middle or on either side of the epiphyseal and metaphyseal joining surfaces.

Degree 2: Radio-opaque area is more than half of the epiphyseal and metaphyseal joining surfaces.

Degree 3: Radio-opaque area is seen in the entire length of the epiphyseal and metaphyseal joining surfaces.

Results and Observations:

The distribution of cases studied in different age groups is shown in Table-1.

1. At 16 years: all the cases in this age group showed degree-3 at the elbow and knee joints. At the wrist, 90% of the cases showed degree-2 and 10% showed degree-3 fusion. At the pelvis, 40% showed degree-1 and 60%, degree-2.
2. At 17 years: Elbow, knee and wrist joints showed degree-3 in all the cases. At the pelvis, 10% showed degree-1, 80% showed degree-2 and the remaining 10% degree-3.
3. At 18 years: Elbow, knee and wrist joints showed degree-3 in all the cases. At the pelvis, 8% of the cases showed degree-1, 68% showed degree-2 and 24% showed degree-3 fusion.
4. At 19 years: Elbow, knee and wrist joints showed degree-3 in all the cases. At the pelvis, 46.7% showed degree-2 and 53.3% showed degree-3.
5. At 20 years: Elbow, knee and wrist joints showed degree-3 in all the cases. At the pelvis, 20% of the cases showed degree-2 and 80% degree-3.

Considering the individual joints, at the elbow and knee joints all the 100 cases showed degree-3. at the wrist joint, 11% showed degree-2, and 89% degree-3. the minimum age showing complete fusion was 16 years and maximum 12 years. At the pelvis, 9% showed degree-1, 58% degree-2, and 33% showed degree-3. The minimum age showing complete union was 17 years and maximum was 20 years.

The Regression Formulae and the Standard Errors derived from each joint are shown in tables 2 and 3 respectively.

Discussion:

Elbow Joint: Galstaun G⁶ from his study on Bengalee subjects opined that complete union at the elbow occurred at 16 years, which is almost similar with the results of this study. Basu SK and Basu S³ recorded the latest time of fusion at the elbow as 17 years, which is later than this study. Lall R and Townsend RS⁸ stated that the fusion around the elbow joint in the north Indian girls was completed by 12-16 years. In this study, at 16 years there is complete union. Aggarwal ML and Pathak IC¹ stated that in Punjabee girls, complete union occurred at the elbow at 16 years, which is almost similar with this study. Chhokar V et al⁴ in their study of 200 female subjects of New Delhi found that complete fusion occurred at 14-16 years which agrees with this series. Sahni D et al⁹ in north west India observed that 100% of the cases in his study showed complete union of the elbow joint epiphyses in the age group of 16-16.9 years and commented that if there is incomplete fusion, the girl is below 16 years of age. This finding seems to be a little later than the finding of this series. Climatic and racial differences may be the reason.

Knee Joint: Galstaun G⁶ also stated the age of fusion as 14-17 years.

Wrist Joint: Galstaun G⁶ observed in bengalee subjects that the lower ends of radius and ulna fused between 12-13 years. The lower limit is different from this series. According to Chhokar V et al⁴, the distal ends of the radius and ulna fused with the shafts at 17-18 years, which lies within the range derived in this series. Banerjee KK and Aggarwal BBL² stated that the wrist joint epiphyseal union is completed at 18-19 years, which is almost similar with the present study.

Pelvis: Galstaun G⁶ observed fusion in bengalee girls, between 17-19 years, which is earlier. Dasgupta et al⁵ in uttar Pradesh found fusion of the iliac crest at 19-20 years which is similar with majority of the cases in this study. Sankhyan S et al¹⁰ in Himachal Pradesh found fusion of the iliac crest in girls at 21 years which is a little later than the finding in this study.

Conclusion:

To determine the age of majority of Manipuri Meitei girls, regression formulae and standard errors of the joints individually and combined have been derived in this study. The one with the minimum standard error for the particular joint concerned can be used.

Table-1: Distribution of cases in different age groups

Age	No. of cases
16 yr	10
17 yr	10
18 yr	50
19 yr	15
20 yr	15

Table-2: Degree of fusion at 16 years

Joint studied	Regression formulae
Elbow	$Y_c = 18.15 + (0)X$
Knee	$Y_c = 18.15 + (0)X$
Wrist	$Y_c = 11.48 + 2.38X$
Pelvis	$Y_c = 15.2 + 1.3X$
Combined	$Y_c = 6.01 + 4.35X$

Table-3: Standard errors at different joints

Joint studied	Standard error
Elbow	±1.1
Knee	±1.1
Wrist	±0.88
Pelvis	±0.91
Combined	±0.80

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Distribution of Fingerprint Patterns among Medical Students

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Abstract

The word "Dermatoglyphics" indicates the study of epidermal ridge pattern on fingers, palm, and soles. Dermatoglyphics are constant and individualistic and form the most reliable criteria of identification. In the present study an attempt has been made to study the fingerprint patterns in medical students at Sikkim-Manipal Institute of Medical Sciences, Gangtok. Fingerprint patterns were studied in 110 students, 55 males and 55 females. Dermatoglyphic prints of the fingertips were taken using the ink method. Distribution of dermatoglyphic fingertip patterns were studied in both hands among males and females and compared.

Key Words: Dermatoglyphics; Fingertip patterns; Gender differences.

Introduction:

Dermatoglyphics have been analyzed since ancient times, but it was identification of an individual from fingerprints that brought a revolution in the field of crime investigation.

Fingerprint is an impression of friction skin ridges, known as dermal ridges or dermal papillae, on a surface. The study of epidermal ridge pattern on fingers, palm, and soles is known as "Dermatoglyphics". Harold Cummins first coined the word in 1926. [1] The dermatoglyphic pattern makes their appearance as early as 10 weeks of intrauterine life [2] Development of ridges was found to be affected by genetic and environmental factors. Once formed these patterns do not change throughout one's life, [3] The fact that skin of palm and soles has ridges that are unique to each individual has been used for personal identification. [4] Study of fingerprint patterns is considered to be the most reliable and absolute method of identification. Galton classified different fingerprint patterns on the basis of their primary pattern as loops, whorls and arches. [5] The distribution of these Galton type fingerprint patterns is said to vary in different population groups, and association of fingerprint patterns with diseases of genetic origin has been reported in the past. [6, 7] Loops are the patterns that start from one side, move towards the centre, curve backwards and terminate on the same side. Whorls are circular or spiral arrangement of ridges in the centre, and in Arches, the ridge lines start from one side and end at the opposite end.

Double loops and central pocket loops are classified under whorls. Although worldwide average distribution of different fingerprint patterns is known, [8] there is paucity of published literature on the distribution of fingerprint patterns on individual digits. The aim of the study was to study the distribution of fingerprint patterns on different digits in males and females and to find if any variation occurs between both sexes for both hands.

Material and Methods:

The study was conducted at Sikkim-Manipal Institute of Medical Sciences, Gangtok during year 2006. The material consisted of rolled fingerprints of 110 medical students, of which 55 were males and 55 females: The age group of the medical students ranged from 19 to 24 years. All healthy individuals with no history of any genetic disorders were included in the study. Ink method as described by Cummins and Midlo, which requires ink slab, inverted 'T' shaped pad, Kores duplicating ink, white paper, magnifying lens and soap was used. The ink was placed on the ink slab and the inverted 'T' shaped pad was soaked in it. The ink was evenly spread on the ink slab. Hands were thoroughly washed with soap before taking prints. The fingers were rolled laterally on the ink slab and then placed on a white paper with one lateral edge and rolled over in opposite direction. Thus the fingerprint patterns were recorded and studied with the help of magnifying lens. Fingerprint patterns were identified as: Loops, Whorls and Arches based on appearance of ridge lines. The present study evaluates the

distribution of dermatoglyphic fingertip patterns in both hands among males and females and the findings of the study are compared with the available data

Results:

A total of 1100 fingerprint patterns were studied. Loops were the most common pattern followed by whorls and arches in both hands among males and females. [Figure 1] While loops were the predominant patterns on the index, middle and little fingers, predominance of whorls was evident on thumb and ring fingers. Loops were most often found on little finger (77.7%) followed by middle finger (73.7%) and index finger (49.1 %). Frequency of whorls was maximum on the ring finger (55%) followed by thumb (53.6%) and index finger (38.2%). 56% of the total arches (n= 50) were present on the index finger. This preference for arches on the index finger was marked in males (68%) when compared to females (44%). There was insignificant difference in overall distribution of fingerprint pattern in both hands among males and females. Frequency of different fingerprint patterns for individual digits in both hands among males and females is shown in table 1 and 2.

Discussion:

The ridge pattern in a fingerprint is genetically determined and highly individualistic. Worldwide percentage distribution of loops, whorls, arches and composite is approximately 65%, 25%, 7% and 2-3% respectively. [8] Although loops were the predominant patterns followed by whorls and arches in our study which is similar to the worldwide average and a study comprising British individuals, [9] frequency of whorls was higher and that of loops lower. Frequency of arches in our study was lower to worldwide average and similar to that found in British population. Overall preponderance of loops among medical students in our study is in accordance with that reported in other studies involving medical students. [10, 11] Frequency of loops and whorls in our study was higher and that of arches lower when compared to study done at Ajmer. [10] In Nellimarla no arches were reported in any of the fingers of the medical students. [11] Our study of fingerprint patterns on individual digits revealed that there was preponderance of loops on the little and middle finger, whorls on the thumb and

ring finger and arches on the index finger in both hands, which is in accordance with the study done on British subjects. [9] However, in our study distribution of arches on the index finger was similar, that of whorls higher and loops on lower side when compared to British population. Loops were more frequently encountered patterns in females and on the left side while whorls were more common in males and on the right side. [Table 1 & 2] The variation between sides is similar to that seen in British population. [9] The overall distribution of different fingerprint patterns however was not significantly different between hands and no statistically significant gender differences could be established, similar to a study done on indigenous black Zimbabweans. [12] However, frequency of loops among Zimbabweans was significantly higher when compared to other studies.

Conclusion:

1. From our study, following conclusions can be drawn:
2. Frequency distribution of fingerprint patterns among Indian Medical students differs from other population groups. Frequency of whorls is comparatively higher and that of loops lower.
3. There was a significant increase in frequency of loops in 3rd and 5th digits, 1st and 4th digits showed predominance of whorls and there is definite preponderance of arches on the index finger.
4. Distribution of fingerprint patterns was similar on both hands for both sexes. Thus while different patterns show preferences for different digits, bilateral variations in the Distribution of fingerprint patterns do not occur. No gender-based differences could be established. Similar studies in other population groups are desirable.

Table No.: 1 Distribution of Fingerprint Patterns in Right and Left Hands

Digit		n	Whorls (%)	Loops (%)	Arches (%)
Thumb	Right	110	62 (56.4)	44 (40)	04 (3.6)
	Left	110	56 (50.9)	52 (47.3)	02 (1.8)
	R+L	220	118(53.6)	96 (43.7)	06 (2.7)
Index	Right	110	40 (36.4)	55 (50)	15 (13.6)
	Left	110	44 (40)	53 (48.2)	13 (11.8)
	R+L	220	84 (38.2)	108 (49.1)	28 (12.7)
Middle	Right	110	24 (21.8)	85 (77.3)	01 (0.9)
	Left	110	26 (23.6)	77 (70)	07(8.4)
	R+L	220	50 (22.7)	162 (73.7)	08 (3.6)
Ring	Right	110	63 (57.3)	44 (40)	03 (2.7)
	Left	110	58 (52.7)	51 (46.4)	01 (0.9)
	R+L	220	121 (55)	95 (43.2)	04 (1.8)
Little	Right	110	23 (20.9)	85 (77.3)	02 (1.8)
	Left	110	22 (20)	86 (78.2)	02 (1.8)
	R+L	220	45 (20.5)	171 (77.7)	04 (1.8)
All Digits	Right	550	212 (38.6)	313 (56.9)	25 (4.5)
	Left	550	206 (37.5)	319 (58)	25 (4.5)
	R+L	1100	418 (38)	632 (57.5)	50 (4.5)

Table 2: Distribution of Fingerprint Patterns among Males and Females

Digit	Sex	Whorls (%)	Loops (%)	Arches (%)
Thumb (n= 110)	Male	59 (53.6)	50 (45.5)	01 (0.9)
	Female	59 (53.6)	46 (41.8)	05 (4.6)
Index (n= 110)	Male	41 (37.3)	52 (47.3)	17(15.4)
	Female	43 (39.1)	56 (50.9)	11 (10)
Middle (n= 110).	Male	28 (25.5)	78 (70.9)	04 (3.6)
	Female	22 (20)	84 (76.4)	04 (3.6)
Ring (n= 110)	Male	61 (55.5)	48 (43.6)	01 (0.9)
	Female	60 (54.6)	47 (42.7)	03 (2.7)
Little (n= 110)	Male	24 (21.8)	84 (76.4)	02 (1.8)
	Female	24 (21.8)	84 (76.4)	02 (1.8)
All Digits (n= 550)	Male	213 (38.7)	312 (56.8)	25 (4.5)
	Female	205 (37.3)	320 (58.2)	25 (4.5)

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Bite Mark Analysis - An Important Tool in Crime Investigation

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Abstract

In the recent years, there has been a rapid increase in the number of suspected bite mark cases examined by the Forensic Odontologists. In some criminal trials, bite mark evidence has been the only evidence on which a conviction or acquittal has been achieved. It is thus important that forensic experts should consider the possibility of human bites while examining surface trauma in certain cases, particularly, alleged rape and child abuse cases. If a human bite is suspected, in the living or in the dead, the value of this evidence must be assessed by proper analysis.

Key Words: Bite Mark, Crime, Evidence, Odontologist, Forensic.

Introduction:

Bite marks are a form of 'patterned injury', which means that the configuration is caused by a particular object. Sometimes bite marks are called as 'tool marks'. Bite mark may also be defined as a mark made by the teeth either alone or in combination with other mouthparts. Bite marks may be found in the living or the dead individuals, where the person may be a victim of the crime or the perpetrator of the crime. Bite marks may also be seen in the food substance or inanimate objects at the crime scene. Bite marks may be produced during assault, abuse of children or on adults associated with sex related crimes. [1]

Detection of crime is difficult and requires painstaking effort by a number of agencies. Advances in forensic sciences have made crime detection scientifically feasible. Human bite marks as incriminatory evidence might be found in foodstuffs, human flesh and other objects. Like fingerprints, the marks made by the human teeth can be a tool for identification. Although historically, dental identification predates fingerprinting, the use of bite mark analysis is just beginning to be recognised and procedures are in the process of development. [2]

Location of bite marks. (Table I) :

Bite marks may be found on almost any surface of the body; specific sites are associated with specific forms of assault. The neck, breasts and shoulders are often bitten in a sexually motivated attack, while in child abuse cases, bites of the arms and the buttocks are common. Adolescent self-inflicted bites can be seen on the medial aspect of the arm. [3,4]

Classification of bite marks:

Tooth pressure marks: These are caused by incisal edges of the anterior teeth. They are stable and subjected to minimal distortion.

Tongue pressure marks: Because of tongue pressure, impressions of the palatal surfaces of the teeth, cingulae or the palatal rugae may be produced. This causes distortion of the marks.

Tooth scrape marks : These are produced because of the irregularities in the teeth due to fractures, restorations etc.

Complex marks : These are a combination of the above types of marks. The shape depends on the amount of tissue taken into the mouth. [5, 6]

Crimes involved in bite marks :

Violent crimes: Such marks may be encountered where the attacker may bite the victim or the victim biting the attacker during defensive responses. In the aggressive type, the teeth are used as a weapon, there is no such mark and the bite is said to be forceful and rapid. In sexual bites, the teeth are used to grip during sucking, the resultant central or peripheral suck marks are visible as petechiae producing the characteristic reddening. This bite is said to be forceful and slow. In many such marks, there may be no visible imprint left by the teeth. [7]

Child abuse cases: The bite marks may be present in any area of the body. The common sites are the arms, hands, cheeks, buttocks, trunk and shoulders.

Sporting events: Here the bite marks are produced when the victim manages to bite the assailant during any type of sports or games.

Self inflicted bite marks : Mostly found on the forearms of the children caused by themselves. Sometimes arms may be pushed into the child's mouth to stop crying or due to intense pain; children may bite themselves because of fear. Mentally retarded and psychologically disturbed people may also inflict bite on themselves. Self inflicted bite marks are also seen in Lesch Nyhan Syndrome, an X-linked recessively transmitted disease with insensitivity to pain. [1]

At the scene of crime : In some cases, the criminals happen to have their teeth marks on the substance left at the scene. Such bite marks may be encountered on inanimate objects like food stuffs or fruits etc. [8]

Nature of human bite mark:

Human bites are usually semicircular or crescentic, caused by the front teeth (incisors and canines), with a gap at either side due to the separation of upper and lower jaw. The teeth may cause clear, separate marks or form a continuous or intermittently broken line. Bite marks may be abrasions, contusions or lacerations or a combination of any two or three. Rarely, the bite mark may be linear in pattern, due to the scraping of the skin by the upper incisors, causing parallel tracks. [9]

Role of consent in recording bite marks :

If a doctor takes an impression of suspect's teeth without his proper consent, it might be regarded as an assault upon him. Therefore, such a procedure may lead to unfortunate legal consequences for the person who takes the impressions. [2]

Recording of bite marks :

The recording of bite marks should be done prior to removal of dead body from the scene of crime. This is because the tooth impression, redness, and bruising have a tendency to disappear very quickly in the cadaver and foodstuffs distort by loss of moisture and inappropriate temperature. In the living subject, bruises change over a period of days, pass off and lessen the mark or impression.

The basic steps in the recording of bite marks are:

Photography: For recording the bite mark, photograph should be taken first, which does not affect any other recording like impression on models, and taking swabs etc.

Impression and models: After completion of the photography, impression of bite mark should be taken before shrinking to changes occur. The best way to record the details of suspect's dentition is to obtain a model of the teeth and directly compare it with the impression of the bite mark.

Collection of swabs: The human beings secrete 'ABO' antigens through their saliva during biting. Swabs should be taken from the bitten area, control area and oral cavity. The bitten area should be removed and preserved in 10-20% formalin solution. Before preservation of tissues, swabs should be taken. [2]

UV illumination: Teeth bite marks which are not visible by naked eye examination may become visible when examined under ultraviolet light in a dark room, because, in a wound, the melanin pigment of the skin shifts to the periphery or margin of the wound, which makes the margins of the teeth bite marks prominent when UV light is focussed on the site of the bite. This technique will demonstrate invisible bite marks upto six months after infliction. [10]

Methods of analysis of bite marks :

The American Board of Forensic Odontology for use in any bite mark analysis has made certain guidelines. These guidelines are considered dynamic and are being modified as significant developments evolve so that the quality of investigation gets enhanced. [11]

Odontometric triangle method: In this objective method, a triangle is made on the tracing of bite marks and teeth models by marking three points, two on the outer most convex point of canines and one in the centre of the upper central incisors. Three angles of the triangles are measured and compared. By comparing bite mark width, bizygomatic and bigonial width from a given bite mark impression, the facial dimensions of a person who is responsible for the mark can also be determined. [12, 13]

Comparison technique: Model from the suspect can be directly placed over the photograph of the bite mark to demonstrate concordant points. Videotape can be used to show slippage of teeth producing distorted images and to study dynamics of the bite marks. [14]

Difficulties in bite mark analysis:

Accuracy of the bite imprint: The impression may not be accurate due to irregularity of the bitten areas on the human skin and the poor quality of the material and time duration between infliction of the bite mark and creation of the model.

Permanency: Unlike fingerprints, which are reasonably constant over the course of an individual's life, the dentition is capable of major changes in configuration, with and without professional intervention. Various restorative materials can change the character of the bitten surfaces or actual position of the individual's teeth. Disease process e.g. caries or periodontal diseases can change the configuration.

Uniqueness: Singular nature of an individual dentition is often assumed, but it has not been definitely established. [2]

Conclusion:

Unlike fingerprints there are a number of factors, which can alter the bite mark evidence. Errors in recording, comparison, analysis and interpretations of bite marks may lead to serious consequences. There should be a criterion regarding the minimum constitution and composition of the bite mark required for effective evaluation. So attempts should be made to establish 'standards' for gathering evidence and interpretation of evidence.

Table I-Common Sites

Non-Sexual	Sexual	
	Hetero	Homo
Arm	Breast	Breast
Leg	Neck	Upper back
Fingers	Cheek	Axilla
Hands	Arm	Arm
Chest	Thigh	Genitalia
Ears	Abdomen	Nose
	Genitalia	Buttocks

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Facial Bilateral Asymmetry

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Abstract

Varying degree of bilateral asymmetry in face has been reported from time to time in humans. This paper attempts to study facial bilateral asymmetry and its changing pattern with age and sex among 200 Dangis and 177 Ahirwars of Khurai block in Madhya Pradesh. Seven facial measurements (five horizontal, two vertical) were taken on subjects categorized into three age groups (3-11years, 12-20 years and above 20 years). The mean and absolute bilateral differences when compared between different age groups and sexes failed to show significant results for most of the measurements. Bilateral facial asymmetry assists in evaluating patients before cranio-facial surgery. Asymmetric measurements are also useful for orthodontics. It is also an important parameter in skull super imposition and photographic comparison.

Key Words: Bilateral, Facial Asymmetry, Age, Sex, Dangi, Ahirwar

Introduction :

The focus of majority of facial asymmetry research has been the identification of the facial side of greatest magnitude. Not all studies found that the dominance was confined to any one side of the face. Many theories on causes of asymmetry based on the observation were put forth, some of which inferred that prenatal environment was a significant factor in the fluctuating asymmetry [1]. Others found evidence that postnatal factors influence asymmetry in the facial skeleton and soft tissue [2]. Bilateral facial asymmetry assists in evaluating patients before cranio-facial surgery [3]. Asymmetric measurements are also useful for orthodontics. It is also an important parameter in skull super imposition and photographic comparison.

Material and Method :

The cross-sectional study was undertaken in the Khurai block of Sagar district in M.P. among two numerically dominant groups Dangi and Ahirwar. Dangi is sub caste group of general caste group Thakur. They are a cultivating caste group found almost exclusively in the Sagar district. Ahirwars, the scheduled caste of tanners and labourers of North India. The sample size comprises of 377 individuals including 200 Dangis (males-100, females-100) and 177 Ahirwars (males-92, females-85) categorized into three age groups i.e. 3-11years, 12-20 years and above 20 years. Individuals with any abnormality in the cephalic facial components were not included in the study. The seven measurements taken on the face were (i) tragon (t) to glabella (g) (ii) tragon (t) to ectocanthus (ec), (iii) tragon (t) to subnasale (sn), (iv) tragon

(t) to chelion (ch), (v) ectocanthus (ec) to endocanthus (en), (vi) ectocanthus (ec) to glabella (g), (vii) ectocanthus (ec) to gonion (go). The present study followed the definition of landmarks laid down by Martin and Saller [4]. Sliding caliper with instrumental error zero was used for taking measurements.

Result and Discussion :

Mean measurement value for right and left facial halves, mean and standard deviation of mean difference and absolute difference for all measurements in males and females have been depicted in table1 to 3 for Dangis and in table 4-6 for Ahirwars.

Changing pattern with age :

Considering only the trend of mean difference between sides in different age groups of Dangi (table 2 and 3), it was found that in males the measurements tragon to glabella, tragon to subnasale and tragon to chelion though exhibited statistical significant difference between lower age groups (3-11years and 12-20 years), only measurement tragon to chelion remain statistically significant when compared for higher age groups (12-20years and above 20 years). While in females only measurement tragon to glabella vary significantly between lower age group (3-11years and 12-20 years) which also becomes statistically insignificant when compared in higher age groups (12-20 years and above 20 years).

Absolute difference in males is statistically insignificant for all age groups. But in females,

measurement trignon to ectocanthus and trignon to chelion exhibited statistically significant difference between lower age groups (3-11years and 12-20 years). While for higher age groups (12-20 years and above 20 years) measurement trignon to ectocanthus vary significantly.

Among Ahirwars, mean difference between sides displays a different trend in comparison to Dangis (table 5 and 6). Among males mean difference is statistically insignificant for lower age group (3-11years and 12-20 years) though for higher age groups (12-20 years and above 20 years) only one measurement trignon to glabella exhibited statistically significant difference. Among females, measurement ectocanthus to gonion for lower age groups (3-11 years and 12-20 years) and measurement trignon to glabella and trignon to chelion for higher age groups (12-20 years and above 20 years) vary significantly.

Comparing the trend of absolute difference it is found that only measurement trignon to chelion is statistically significantly varying for higher age groups (12-20 years and above 20 years) among males and for lower age groups (3-11years and 12-20 years) in females.

Sex comparison :

The mean and absolute difference was compared between sex in all age groups of Damgi and Ahirwar. Mean difference did not show any significant result. While considering

absolute difference, the measurement ectocanthus to endocanthus in age group 3-11years (Table-1) among Dangis and measurement trignon to chelion among Ahirwars in 12-20 years age group (Table-5) are statistically significantly varying between sexes.

Shaner et al [5] found statistically significant mean difference between measurement values of two sides of the face, among male (trignon to glabella and ectocanthus to gonion) and among females (ectocanthus to glabella and ectocanthus to gonion). But in the present study not even a single measurement showed statistically significant difference though statistical difference was present in all the measurements. Skavarilova [6] studying facial asymmetry among children from six to eighteen years found no sex and age difference. While Ferrario et al [7] studying white individuals found differences between the two sexes : landmarks on the right sides of the male face were wider laterally and situated more cranially and anteriorly, whereas female face also had landmarks that were wider on the right side, but they were more caudally and posteriorly placed on this side. After a thorough survey of literature no comparable study on the effect of sex and age on mean and absolute asymmetry difference were found. Therefore the present result can not be compared with others.

Table-1 Mean bilateral asymmetry difference and absolute difference among Dangis (3-11yrs)

Measurement (cms)	Side	Mean of sides	Male (N=14)				Female (N=15)				
			Mean difference		Absolute difference		Mean of sides	Mean difference		Absolute difference	
			Mean	SD	Mean	SD		Mean	SD	Mean	SD
t-g	Right	9.79	0.11	0.09	0.12	0.07	9.73	0.07	0.07	0.10	0.04
	Left	9.68					9.66				
t-ec	Right	5.67	0.01	0.09	0.07	0.06	5.67	0.05	0.05	0.11	0.03
	Left	5.66					5.62				
t-sn	Right	9.51	0.07	0.08	0.10	0.04	9.63	0.06	0.06	0.10	0.07
	Left	9.44					9.57				
t-ch	Right	7.89	-0.07	0.16	0.14	0.10	8.38	0.03	0.03	0.13	0.08
	Left	7.96					8.36				
ec-en	Right	2.83	0.01	0.11	0.07	0.07	2.85	-0.02	0.05	0.13*	0.04
	Left	2.82					2.88				
ec-g	Right	4.83	0.02	0.12	0.09	0.07	4.89	-0.05	0.73	0.11	0.03
	Left	4.81					4.94				
ec-go	Right	6.74	-0.05	0.13	0.12	0.07	7.01	-0.73	0.02	0.14	0.09
	Left						7.08				

* Sexual difference significant at p ≤ 0.05

Table-2 Mean bilateral asymmetry difference and absolute difference among Dangis (11-20 yrs)

Measurement (cms)	Side	Male (N=18)					Female (N=18)				
		Mean of sides	Mean difference		Absolute difference		Mean of sides	Mean difference		Absolute difference	
			Mean	SD	Mean	SD		Mean	SD	Mean	SD
t-g	Right	11.15	-0.02 #	0.12	0.11	0.05	10.74	0.01	0.09	0.08	0.04
	Left	11.16					10.23				
t-ec	Right	6.82	0.03	0.11	0.10	0.50	6.41	-0.01	0.09	0.07 #	0.04
	Left	6.79					6.39				
t-sn	Right	11.59	-0.03 #	0.11	0.10	0.05	10.95	0.01	0.12	0.12	0.05
	Left	11.61					10.95				
t-ch	Right	9.87	0.16 #	0.20	0.20	0.16	9.52	0.02	0.31	0.24 #	0.18
	Left	9.71					9.52				
ec-en	Right	3.18	-0.01	0.11	0.09	0.06	3.13	0.02	0.14	0.11	0.09
	Left	3.20					3.16				
ec-g	Right	5.43	-0.03	0.11	0.10	0.05	5.24	-0.02	0.10	0.08	0.05
	Left	5.45					5.30				
ec-go	Right	8.68	-0.03	0.13	0.12	0.05	8.30	-0.05	0.09	0.10	0.03
	Left	8.71					8.35				

- Age difference between age group 3-11 years and 12-20 years significant at $p \leq 0.05$

Table-3 Mean bilateral asymmetry difference and absolute difference among Dangis (Above 20 years)

Measurement (cms)	Side	Male (N=67)					Female (N=67)				
		Mean of sides	Mean difference		Absolute difference		Mean of sides	Mean difference		Absolute difference	
			Mean	SD	Mean	SD		Mean	SD	Mean	SD
t-g	Right	11.51	0.02	0.12	0.11	0.05	10.81	-0.01	0.12	0.11	0.04
	Left	11.49					10.82				
t-ec	Right	6.94	0.01	0.10	0.09	0.04	6.57	-0.02	0.10	0.11#	0.11
	Left	6.93					6.58				
t-sn	Right	11.80	0.02	0.12	0.11	0.05	10.84	-0.01	0.13	0.12	0.05
	Left	11.79					10.85				
t-ch	Right	10.29	-0.08#	0.15	0.15	0.07	9.43	-0.01	0.18	0.15	0.09
	Left	10.38					9.45				
ec-en	Right	3.13	0.01	0.11	0.10	0.03	3.01	0.01	0.11	0.09	0.05
	Left	3.12					2.99				
ec-g	Right	5.67	0.01	0.11	0.11	0.02	5.31	0.01	0.12	0.10	0.06
	Left	5.65					5.29				
ec-go	Right	9.29	-0.04	0.13	0.12	0.05	8.52	-0.02	0.15	0.13	0.06
	Left	9.31					8.54				

- Age difference between age group 12-20 and above 20 years significant at $p \leq 0.05$

Table-4 Mean bilateral asymmetry difference and absolute difference among Ahirwars (3-11yrs)

Measurement (cms)	Side	Male (N=15)					Female (N=15)				
		Mean of sides	Mean difference		Absolute difference		Mean of sides	Mean difference		Absolute difference	
			Mean	SD	Mean	SD		Mean	SD	Mean	SD
t-g	Right	9.83	0.03	0.12	0.11	0.03	9.28	0.06	0.14	0.13	0.08
	Left	9.86					9.23				
t-ec	Right	5.66	0.01	0.11	0.10	0.04	5.46	0.06	0.13	0.13	0.06
	Left	5.64					5.40				
t-sn	Right	9.64	0.06	0.11	0.12	0.04	9.08	0.03	0.13	0.12	0.04
	Left	9.59					9.06				
t-ch	Right	8.50	-0.05	0.18	0.16	0.07	7.82	-0.03	0.15	0.14	0.06
	Left	8.55					7.85				
ec-en	Right	2.74	-0.01	0.10	0.10	0.01	2.66	-0.03	0.12	0.11	0.03
	Left	2.74					2.70				
ec-g	Right	4.78	-0.01	0.11	0.11	0.03	4.61	-0.06	0.11	0.11	0.03
	Left	4.77					4.65				
ec-go	Right	7.27	-0.04	0.14	0.13	0.05	6.86	-0.02	0.12	0.11	0.03
	Left	7.31					6.88				

Table-5 Mean bilateral asymmetry difference and absolute difference among Ahirwars (12-20 yrs)

Measurement (cms)	Side	Male (N=18)					Female (N=18)				
		Mean of sides	Mean difference		Absolute difference		Mean of sides	Mean difference		Absolute difference	
			Mean	SD	Mean	SD		Mean	SD	Mean	SD
t-g	Right	10.72	0.08	0.11	0.13	0.05	10.34	0.08	0.09	0.12	0.09
	Left	10.64					10.25				
t-ec	Right	6.64	0.04	0.12	0.12	0.04	6.30	0.01	0.12	0.11	0.12
	Left	6.63					6.28				
t-sn	Right	10.90	0.06	0.12	0.13	0.05	10.58	0.06	0.11	0.12	0.11
	Left	10.84					10.52				
t-ch	Right	9.78	-0.02	0.13	0.12	0.05	9.47	-0.07	0.20	0.19*#	0.20
	Left	9.81					9.55				
ec-en	Right	2.96	-0.01	0.11	0.10	0.03	3.03	0.04	0.10	0.10	0.10
	Left	2.98					2.98				
ec-g	Right	5.18	-0.01	0.12	0.10	0.05	5.18	0.06#	0.09	0.11	0.09
	Left	5.20					5.12				
ec-go	Right	8.32	-0.01	0.13	0.12	0.05	8.23	-0.02	0.16	0.13	0.16
	Left	8.32					8.25				

* - Sexual difference significant at $p \leq 0.05$

- Age difference between age group 3-11years and 12-20 years significant at $p \leq 0.05$

Table-6: Mean bilateral asymmetry difference and absolute difference among Ahirwars (Above 20 years)

Measurement (cms)	Side	Male (N=59)					Female (N=52)				
		Mean of sides	Mean difference		Absolute difference		Mean of sides	Mean difference		Absolute difference	
			Mean	SD	Mean	SD		Mean	SD	Mean	SD
t-g	Right	11.11	0.02#	0.13	0.12	0.05	10.56	0.01#	0.12	0.11	0.04
	Left	11.07					10.55				
t-ec	Right	6.78	-0.01	0.12	0.11	0.04	6.61	-0.05	0.11	0.11	0.04
	Left	6.82					6.65				
t-sn	Right	11.07	0.02	0.13	0.12	0.05	10.68	0.01	0.12	0.12	0.05
	Left	11.06					10.67				
t-ch	Right	10.24	0.01#	0.19	0.17#	0.08	9.81	0.04#	0.19	0.17	0.08
	Left	10.22					9.77				
ec-en	Right	3.29	0.02	0.12	0.11	0.04	3.09	0.02	0.12	0.11	0.05
	Left	3.17					3.06				
ec-g	Right	5.58	0.04	0.11	0.11	0.04	5.36	0.03	0.11	0.11	0.04
	Left	5.55					5.34				
ec-go	Right	8.73	-0.02	0.14	0.13	0.06	8.43	0.05	0.44	0.18	0.04
	Left	8.76					8.45				

- Age difference between age group 12-20 years and above 20 years significant at $p \leq 0.05$

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Medicolegal Case Handling: A Case History

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Abstract

Handling of a medicolegal case not only needs clinical knowledge but also sound knowledge of legal obligations of a doctor to avoid legal complications in future. This case report deals with lack of knowledge and carelessness on the part of doctors involved in patient care.

Key Words: Medicolegal, Clinical, Legal, Obligation.

Introduction:

The Court under Sections 177 and 193 IPC served six doctors summons on November 04, 2006. Not only doctors but six other staff members of the hospital were directed to appear in person before the court on January 12, 2007. Delhi Police on November 01, 2006 filed a charge sheet accusing Apollo Hospital's Management and its doctors for deliberately misleading the probe into alleged abuse by Rahul Mahajan. The charge sheet filed before the additional Chief Metropolitan Magistrate alleged that the private hospital and its six doctors committed the offence to save Rahul. [6]

To avoid Apollo Hospital's like situation in Handling Rahul Mahajan's case, doctors must be well acquainted with the legal obligation in addition to clinical skills. This case report is also related to handling of a medicolegal case by not following legal obligations. This will not only leads to damage of the reputation of the hospital as well as doctors but also causes great inconvenience to patients and their relatives later on.

Case History:

A female patient "x" w/o "y" aged about 45 years R/O Umrain, Airwa Katra, District Auria, U.P. alleged to met with an accident from behind by a mobike Yamha Crux, registration No. U.P. 75-F-2832. Alleged accused "z" alias Gappu S/O "F" R/O Umrain, Airwa Katra, District Auria, U.P. Victim alleged that due to rash and negligent driving she suffered injuries at the back on 13-08-2006 at about 11.00 a.m.

Victim was accompanied with her son who called his father and both brought the patient to the local doctor at Bharthna, Etawah. Villagers and relatives of both the sides reached at consensus that alleged accused will bear the expenses if case is not registered at the police station. The condition of the patient did not improved and they approached a

private doctor at Etawah, who referred the patient to the Rural Institute of Medical Sciences and Research, Saifai, Etawah for further treatment.

Patient reached at the casualty department on 13-08-2006 at about 10.30 a.m. but Medical Officer on duty after knowing that patient is having the problem of orthopedics asked him to go directly to the Orthopedics OPD without thinking of that it may be a medicolegal case. No medicolegal was done and no entries are made in the casualty register.

In the Orthopedics OPD patient was attended by the Senior and Junior Residents both on duty. They advised for x-ray of Pelvis Joint and making diagnosis of Lumber Vertebra fracture in the OPD card without thinking of that it may be a medicolegal case. They advised the patient bed rest and other symptomatic treatment and initialed in place of full signature in the OPD card. Patient reached the Orthopedics OPD again on 23-08-2006 at about 10.00 a.m. and advised to get admitted. No attempt was made to rule out the possibility of a medicolegal case. No detailed examination or history is written in the case sheet of the patient. Patient was discharged on 26-08-2006.

When accused refused to bear the expenses for treatment, patient lodged FIR at Airwa Katra Police Station after about one month of incident i.e. on 10-09-2006. Investigation Officer (SI) G.D. Singh wrote a requisition in favour of Medical Superintendent (M.S.), Rural Institute of Medical Sciences & Research, Saifai, Etawah dated 14-09-2006 asking for the patient's record of treatment and medicolegal report. Victim's relative tried for the patient's record on many occasions but without any result.

Medical Superintendent when approached make a not on the same letter directing Emergency Medical Officer on duty to provide duplicate copy of patient's record and medicolegal report but immediately cut the statement and without making any attempt to

know the reality refused to issue any document on the basis that the patient is not attended the casualty. When patient's relative contacted the author, he along with other team members investigated the whole case and studied from the ethical and medicolegal angle and decides to present as a case report. Deficiency in handling this case from medicolegal angle is brought forward in the light of Apex Court's landmark Judgments in dealing with accident cases. All the deficiencies are grouped as follows:

Circumstances of the case:

FIR was not lodged on the pretext of accused promise to bear the expenses for the treatment and social pressure. Victim and her relatives think of only minor injuries. But latter on when patients condition was not improved and x-ray examination revealed of fracture of lumber vertebra and accused refusal to bear the expenses for the treatment she lodged FIR after about one month. Since Patient was from poor socioeconomic background, she might be provoked by others with wasted interests to extract more money from the alleged accused. It may be an afterthought. All these possibilities could not be ruled out. Whatever be the reason, after lodging FIR on 10-09-2006 her case becomes a genuine medicolegal case.

Role of EMO:

Emergency Medical Officer (EMO) on duty on 17-08-2006 must have taken detailed history and must have done through examination along with specialist's consultation in place of asking the patient to go directly to the Orthopedics Out Patient Department (OPD). He clearly violated Apex Court's directions, along with professional ethics and deserves for administrative action.

Role of Orthopedics Department:

Doctors on duty in the Ortho OPD failed to elicit detailed history and possibility of ruling out medicolegal case. They even not admitted the patient on the same day i.e. on 17-08-2006. Even OPD record of 23-08-2006 failed to enter the name of patient in the OPD register on the day of admission. Doctors in the OPD being more qualified are more responsible for patient care and keeping all the record up to date then the EMO. They violated Apex Court's directions along with ethical guidelines for putting his full name along with signatures.

Role of the Medical Superintendent:

It is failure on the part of the MS to implement the Apex Court's direction as well as the Code of Medical Ethics. As he did not make any attempt to know the reality of the case, he denied the issue of the patient's record to her representative against the provision in the MCI Regulations-2002. [1] Failure to do periodical inspection, and issue guidelines, on

the part of Medical Superintendent as part of general administration of the hospital is in clear violation of directions of the Apex Court.

What are Apex Court's Guidelines?

Apart from the recommendations made by the Committee in that regard and the action taken by the State Government in the memorandum dated 22-08-1995 on the basis of the recommendations of the Committee, we are of the view that in order that proper medical facilities are available for dealing with emergency cases it must be that:

1. **Adequate facilities** are available at the **Primary Health Centres** where the patient can be **given immediate primary treatment** so as to **stabilize his condition**.
2. **Hospitals** at the **district level** and **sub-divisional level** are **upgraded** so that **serious cases can be treated there**.
3. **Facilities for giving specialist treatment** are increased and are available at the hospitals at **district level** and **sub-divisional level** having regard to the growing needs.
4. In order to ensure **availability of bed** in an emergency at State level hospitals there is a **centralized communication system** so that the patient can be sent immediately to the hospital where bed is available in respect of the treatment, which is required.
5. **Proper arrangement for ambulance** is made for the transport of a patient from the Primary Health Center to the District Hospital or Sub-divisional hospital to the State.
6. The ambulance is adequately provided with necessary equipment and medical personnel.
7. The Health Centers and the hospitals and the medical personnel attached to these Centers and hospital are geared to deal with larger number of patients needing emergency treatment on account of higher risk of accidents on certain occasions and in certain seasons. [2]

Regarding provision of Ambulance Services:

- Proper arrangement for ambulance is made for the transport of a patient from the Primary Health Centre to the District Hospital or Sub-divisional hospital to the State. [2], 7, 8]
- The ambulance is adequately provided with necessary equipment and medical personnel. [2, 1]

Adequate Allocation of budget:

It is no doubt true that financial resources are needed for providing these facilities. But at the same time it cannot be ignored that it is the constitutional obligation of the State to provide adequate medical services to the people. Whatever is necessary for this purpose has to be done. In the context of the constitutional obligation to provide free legal aid to a

poor accused this Court has held that the State cannot avoid its constitutional obligation in that regard on account of financial constraints. [4]

The said observations would apply with equal, if not greater, force in the manner of discharge of constitutional obligation of the State to provide medical aid to preserve human life. In the matter of allocation of funds for medical services the said constitutional obligation of the State has to be kept in view. It is necessary that a time-bound plan for providing these services should be chalked out keeping in view the recommendations of the Committee as well as the requirements for ensuring availability of proper medical services in this regard as indicated by us and steps should be taken to implement the same.

The State of West Bengal alone is a party to these proceedings. Other States, though not parties should also take necessary steps in the light of the recommendations made by the Committee, the directions contained in the memorandum of the West Bengal dated 22-08-1995 and the further directions given herein. [2]

Joint Obligation of the Union and State Government:

The Union of India is a party to these proceedings since it is the joint obligation of the Centre as well as the States to provide medical services it is expected that the Union of India would render the necessary assistance in the improvement of the medical services in the country on these lines. [2]

Administrative Action against Guilty:

As regards the Medical Officers who have been found to be responsible for the lapse resulting in denial of immediate medical aid to victim it is expected that the State Government will take appropriate administrative action against those officers. [2] This will act as deterrent for others so future recurrences could be avoided. A copy of this judgment is send for taking necessary action to the Secretary, Medical and Health Department, of the States. [2]

Regarding referral of patients:

The Court mention that whenever on such occasions a man of the medical profession is approached and if he finds that whatever assistance he could give is not sufficient really to save the life of the person but some better assistance is necessary it is also the duty of the man in the medical profession so approached to render all the help which he could and also see that the person reaches the proper expert as early as possible. [4]

What to do in case of non-availability of beds in casualty?

In case of non-availability of beds patients could very well be kept on trolley-beds or even on the floor

for the time being and could be transferred to the cold ward, as the situation demanded temporarily. [2, 7, 8] Beds could also be made available by transferring patients to cold wards. EMO concerned should take personal efforts to make beds available or should contact the superior authority over the telephone if there is any stringency as to the beds available and admit the patient in spite of the total sanctioned beds not having been available. The Medical Superintendent should give guidelines to the respective Medical Officers for admitting serious cases under any circumstances, because he is responsible for the general administration of the hospital. [2]

A Central Bed Bureau should be set up which should be equipped with **wireless** or **other communication facilities** to find out where a particular emergency patient can be accommodated when a particular hospital finds itself absolutely helpless to admit a patient because of physical limitations. In such cases hospital concerned should contact immediately the Central Bed Bureau which will communicate with the other hospitals and decide in which hospital an emergency moribund / serious patient is to be admitted. [2, 7, 8]

Regarding Fixing of the Responsibility:

The Medical Superintendent of the hospital must be held responsible for general state of affairs that no provision was made for admitting any patient even if his condition was serious. [2]

Emergency Medical Officer will get in touch with Medical Superintendent / Deputy Medical Superintendent / Specialist Medical Officers for taking beds on loan from cold wards for accommodating such patients as extra temporary measures. Medical Superintendent of hospitals will issue regulatory guidelines for admitting such patients on internal adjustments amongst various wards and different kinds of beds including cold beds and will hold regular weekly meetings for monitoring and reviewing the situation. A model of such guidelines should be available with everybody concerned, which will be suitably amended according to local arrangements prevailing in various establishments. [2]

As regards the Medical Officers who have been found to be responsible for the lapse resulting in denial of immediate medical aid to victim, it is expected that the State Government will take appropriate administrative action against those officers. [4] In a case [7] Apex Court in the context of medicolegal cases, has emphasized the need for rendering immediate medical aid to injured persons to preserve life and the obligations of the State as well as doctors in that regard. In all it is Emergency Medical Officer concerned as well as Medical

Superintendent which must be held responsible for non admission of a serious case in the hospital.

References:

1. The Indian Medical Council (Professional Conduct, Etiquette and Ethics) Regulations-2002.
2. Paschim Banga Khet Mazdoor Samity and Others v. State of W.B. and Others, 1996 (4) SCC 37, Writ Petition (c) No. 796 of 1992 (under Article 32 of the Constitution.)
3. Khatri (II) v. State of Bihar (1981) 1 SCC 627: 1981 SCC (Cri) 228
4. Nilabati Behera v. State of Orissa (1993) 2 SCC 746
5. Consumer Unity & Trust Society v. State of Rajasthan (1991) 1 CPR 241 (NC).
6. The Times of India, November 4, 2006: 13.
7. Parmanand Katara v. Union of India (1989) 4 SCC 286: 1989 SCC (Cri) 721
8. Dr. R. K. Sharma, Legal Aspects of Patient Care, 'Emergency Services in Hospitals: Supreme Court Guidelines', First Edn.-2000; ISBN No.; 81-7724-006-4: 82-83.

